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Meso–Cenozioc Tectonic Attribute of Southern China and Folding of the Nanhua (South Cathay) Orogenic Belt

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Abstract The Meso–Cenozoic tectonic attribute of southern China is a continental tridirectional orogenic belt formed by subsynchronous interaction among the Tethys, Northwest Pacific and Kunlun–Qinling tectonic domains. It was created by superimposition of repeated orogenies since the Late Permian. The Indosinian folds therein are gentle and localized.

Key words: continental tridirectional orogenic belt, platform cover, Indosinian orogeny, Meso–Cenozoic, southern China

1 Introduction

All the post–Palaeozoic structural layers except the Quaternary in southern China were folded, accompanied by strong magmatism, resulting in the formation of the Meso–Cenozoic Nanhua (South China) orogenic belt— a continental tridirectional orogenic belt. The orogen is utterly different from the famous orogenic belts, such as the Caledonides, Appalachides, Hercynides and Alpides. The overwhelming majority of Chinese geologists consider that the folds of the Devonian–Triassic structural stages in southern China mainly belong to the Indosinides. There is evidence, however, that: (1) the folding of the Indosinian orogeny was rather weak; (2) the Devonian–Triassic structural layers were folded almost synchronously with those of the Meso–Cenozoic basins; (3) the parasynchronous folds resulted from superimposition of repeated orogenies that had taken place one after another since the Late Permian. The author carried out an investigation of structural geology in Guangxi, Guangdong, Hunan and Jiangxi to confirm these specutations (Fig. 1).

2 Two Major Prominent Characteristics of the Nanhua Orogenic Belt

The Nanhua orogenic belt is a continental, tridirectional orogenic belt.

2.1 Continental orogenic belt

The Nanhua continental orogenic belt is defined as such that the geological bodies

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inovolved were deformed under monmarine tectonic environment, which is different from the marine geosynclinal environment in that the deformed rocks consist dominantly of the Sinian–Middle Triassic or Devinian–Middle Triassic platform cover and the structural layers of Mesozoic–Cenozoic basins in addition to some turbidites (flysch) and mélanges. Argand (1922) called this kind of deformation "plissements a sec".

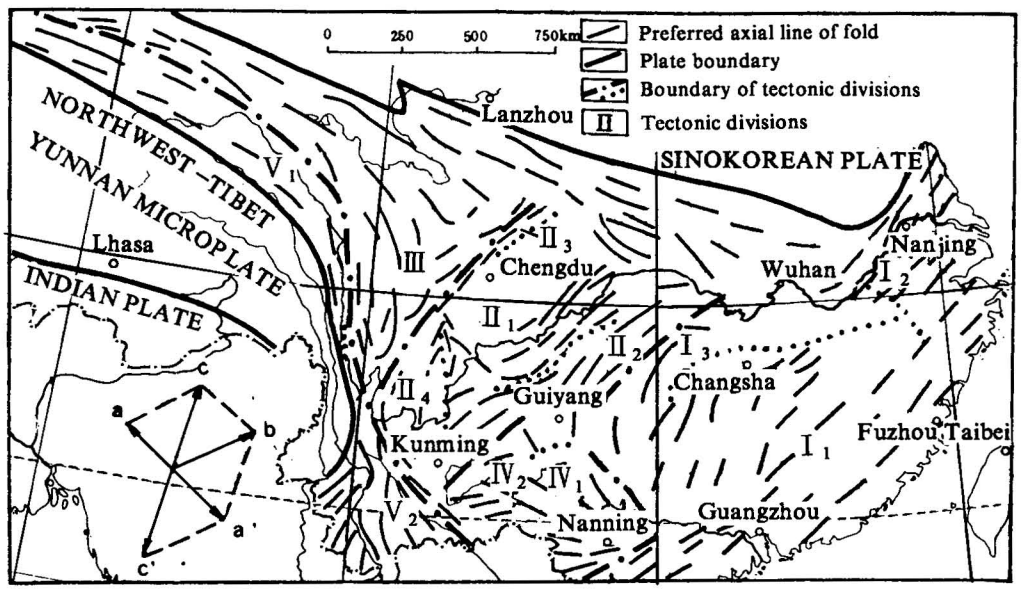

Fig. 1. Preferred tectonic lines and tectonic division of folding age of the Nanhua orogenic belt in the Chinese continental part of the South China–Southeast Asian plate.

Meso–Cenozoic Northwest Pacific tectonic domain: I–Peri–Pacific region; I_1–Cathaysian subregion; I_2–Lower Yangtze subregion; I_3–Jiangnan subregion; II –Intracontinental region; II $_1$–Central Sichuan subregion; II $_2$–East Sichuan subregion; II $_3$–Longmenshan subregion; II $_4$–Kangdian subregion. Meso–Cenozoic Tethys tectonic domain: III –Bayan Har region; IV –Youjiang region; IV $_1$–West Guangxi subregion; IV $_2$–Southeast Yunnan–South Guizhou subregion; V –Qamdo–Simao region; V $_1$–Qamdo subregion; V $_2$–Simao subregion.

2.2 Tridirectional orogenic belt

The Nanhua orogenic belt is a tridirectional orogenic belt formed by nearly synchronous interaction of three tectonic domains, with the resulting tectonic lines mainly of NW trend in the west, NE trend in the east and WNW trend on the north margin (Fig. 1). According to the preferred directions of folds, faults and magmatic activity and long axis of basins, the Nanhua orogenic belt can be broadly divided into three parts: the east part (regions I –II), the west part (regions III –V) and the north marginal part, which belong to the Meso–Cenozoic Northwest Pacific tectonic domain, Tethys tectonic domain and Kunlun–Qinling tectonic domain respectively. There is no clear–cut boundary between each two of them since they are merging one into the other. The first two are active tectonic domains, which were formed by the action exerted by forces a and b as a result of the spreading of the Pacific Ocean, Tethys Ocean and Indian Ocean (Fig. 1). The mainly NE–trending tectonic line in the east runs nearly parallel to the Northwest Pacific coast, which implies that this might

have resulted from the interaction between the Kula–Pacific plate and the Eurasian plate. The mainly NW–trending tectonic line in the west is nearly parallel to the Tethys coast, which implies that this might result from the interaction between the Indian plate and the Eurasian plate. The resultant of forces a and b might bring about the stressing between the South China–Southeast Asian subplate and the Tarim and Sino–Korean palaeoplates within the Eurasian plate to form the passive Kunlun–Qinling tectonic domain, whose tectonic line trends WNW. The relative boundary of the Kunlun–Qinling tectonic domain is not pronounced and thus not indicated in Fig. 1.

2.3 Orogeny in the Sichuan–Yunnan continental extensional basin

The Sichuan–Yunnan continental extensional basin runs in a NE diection across the Nanhua orogentic belt, thus complicating the morphology of the orogenic belt. It has undergone extension since the Late Triassic (Guo, 1996) such that the structural layers near the median rise of the basin have remained very gentle or horizontal and that the marginal mountain ranges, such as the Longmen, Daba and Huaying mountains, trend parallel to the basin margin. The extension was thought to be responsible for the formation the box–like folds in eastern Sichuan.

3 Folding of the Nanhua Orogenic Belt

Quite a number of Chinese geologists consider that the Indosinian orogeny was manifested by intense folding (Huang,1960), which affected the Devonian–Triassic cover all over the South China paraplatform (Ren et al., 1980). Actually the Indosinian orogeny only caused the platform cover to begin to be slightly folded. The fold morphology and intensity of the platform cover and overlying Mesozoic structural layers are similar; their strike and dip are generally consistent in the case of non–fault contact; the age of the folding of the platform cover is quite young and varies from place to place.

3.1 Peri–Pacific region (Ⅰ)

According to the difference in folding process the region is divided into three subregions, i.e.: Cathaysian, Lower Yangtze and Jiangnan. The folding process of the Cathaysian subregion (I_1) can be appreciably expressed in Fig. 2. (1) The Indosinian orogeny represented by the unconformity below the Genkou Group (T_3g) (Fig. 2B and 2C) only resulted in the first slight folding of the platform cover (T_1d) (105° ∠30° –110° ∠35° ;105° ∠35° –120° ∠40°). (2) A successive orogeny marked by the unconformity below the Gaojiping (K_1g) (Fig. 2B and 2C) brought about the second folding of the platform cover (T_3g). (3) The third successive orogeny represented by the unconformity below the Guancaohu Group (K_2g) (Fig. 2C) caused folding of the platform cover (K_1g). (4) The folding of the Guancaohu Group (K_2g) immediately following that of the Gaojiping Group (K_1g) implies another succeeding orogeny took place after the middle Cretaceous (Fig. 2C). (5) The platform cover (T_1d, P_1t) and the Mesozoic structural layers of he basins (T_3g, K_1g and K_2g) (Fig. 2B and 2C) were folded parasynchronously with similar fold shapes.

In the lower Yangtze subregion (I_2) the Indosinian (Nanxiang) orogeny occurred between the Triassic and Jurassic and only resulted in local slight folding, and after it at least five successive orogenies occurred. In the Jiangnan subregion (I_3) there are no notable Indosinidan folding, and folds of the Devonian–Middle Jurassic structural layers were

formed by repeated orogenies since the Late Jurassic.

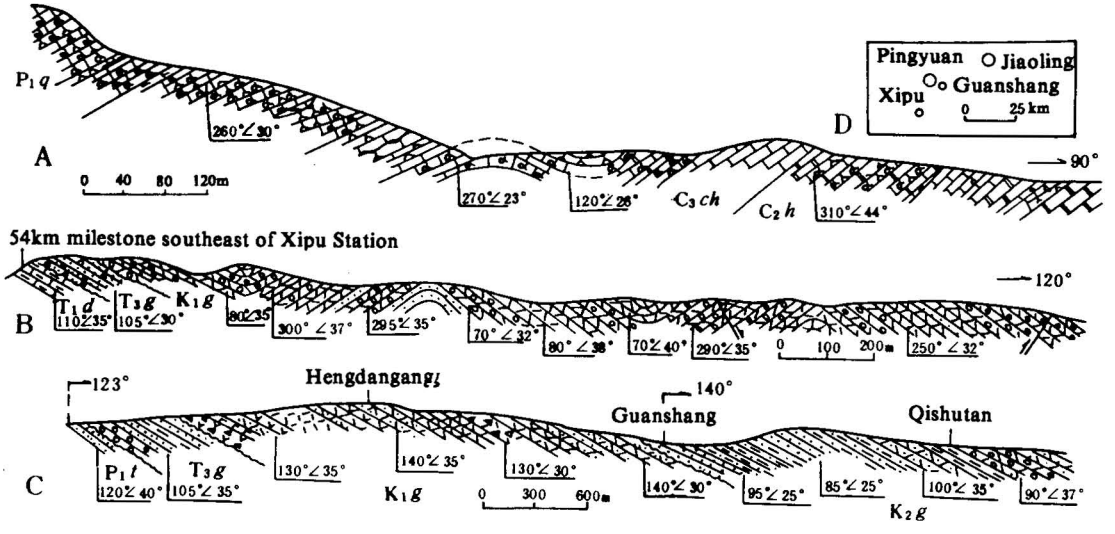

Fig. 2. Parasynchronous folding of the platform cover and Mesozoic basinal structural layers of northeastern Guangdong.

A. Structural section of the platform cover of Baihu, Jiaoling County (after Bureau of Geology and Mineral Resources of Guangdong Province, 1989); B. Structural section of the platform cover and Mesozoic basinal structural layers of Xipu, Xingning City; C. Structural section of the platform cover and Mesozoic basinal structural layers of Guanshang, Pingyuan County; D. index map of the section positions. Platform cover: C_2h–Huanglong Formation; C_3ch–Chuanshan Formation; P_1q–Qixia Formation; P_1t–Tongziyan Formation; T_1d–Daye Formation; Mesozoic basinal stages: T_3g–Genkou Group; K_1g–Gaojiping Group; K_2g–Guancaohu Group.

3.2 Intracontinental region (Ⅱ)

The wide folding of the platform cover and Meso–Cenozoic strutrural layers underlying the Lijiang Formation (Upper Eocene–Oligocene) resulted from the Sichuan orogeny between the Middle and Late Eocene. The first local slight folding of the platform cover around the region occurred somewhat earlier, e.g. between the Middle and Late Triassic in the Kangdian subregion (Ⅱ$_4$), between the Triassic and Jurassic in the Longmenshan subregion (Ⅱ$_3$) and in the Late Jurassic in the east Sichuan subregion (Ⅱ$_2$).

3.3 Bayan Har region (Ⅲ)

The folding of the Late Palaeozoic–Middle Eocene structural layers took place mainly between the Middle and Late Eocene, and is marked by the regional angular unconformity below the Relu Formation–Hongtupo Formation (Upper Eocene–Oligocene). Several local slight folding events had occurred before, which are respectively represented by the unconformities below the Upper Permian, Lower Triassic, Qugasi Formation (T_3q), Nianbao Formation (J_1n), Yematan Formation (J_2y), Wanxiu Group (k_1w) and Fenghoushan Group (K_3–E_2f).

3.4 Youjiang region (Ⅳ)

The age of the folding of the platform cover (D–P) and of the Youjiang basinal structural layers of the Youjiang basin (T_1–T_2) is the same as that of the Bayan Har region. Before it three events of gentle folding took place in the west Guangxi subregioon (IV_1), represented by the unconformities underlying the Wangmen Formation (J_1w), Xinlong Formation (K_2x) and Xidong Formation (K_3x) respectively. The unconformity below the Wangmen Formation is a record of gentle folding produced during the Indosinian orogeny between the Middle and Late Triassic according to regional data. There are no Indosinian folds in the southeast Yunnan–south Guizhou subregion (IV_2) because the Upper Triassic lies conformably on the Middle Triassic.

3.5 Qamdo–Simao region (V)

Wide intense folding occurred between the Middle and Late Eocene, marked by the regional striking unconformity below the Mengla Group–Gonjo Group (E_2–E_3m). The folds were formed by collision between the Indian and Eurasian plates. Before it two local slight foldings occurred, represented respectively by the unconformities below the Tuoba Formation (P_2t) and Jiapeila Formation (T_3j) in the Qamdo subregion (V_1). The Simao subregion (V_2) remained rather stable. The conformable relationship of the rock sequence from the Devonian through Middle Eocene indicates the absence of either Indosinian or older and younger folds.

4 Discussion

4.1 Interrelation between the Meso–Cenozoic Tethys and Northwest Pacific tectonic domains

The subsynchronous interaction of the Turkey–Central Iran–Gangdise median plate–Indian plate, Kula–Pacific plate and Eurasian plate resulted in some consistent tectonic events in the two interrelated tectonic domains. The Mengla orogeny between the Middle and Late Eocene resulted from collision of the Indian plate and the Eurasian plate. It is the most intense folding known in the study area, which formed the dominantly NW–trending tectonic lines in the Tethys tectonic domain. The long accumulated compression–shear stress in the Northwest Pacific tectonic domain was triggered by the collision between the Indian plate and the Eurasian plate to give rise to the Sichuan orogeny between the Middle and Late Eocene that brought about the wide folding of the platform cover and Meso–Cenozoic structural layers mainly of NE trend. The two orogenies are of the same age and so are the Xiqinling and Genkou–Anyuan orogenies occurring between the Middle and Late Triassic and the Bayan Har and Nanxiang orogenies occurring between the Late Triassic and the Early Jurassic. Of course, there are a lot of different tectonic events in the two tectonic domains. The interrelation caused the unique feather–shaped symmetry in orientation of tectonic lines, orogenic eras, generations of magmatism–mineralization, series of basin development and their ages from the inland to the Tethys Ocean coast and to the Northwest Pacific Ocean coast respectively is attributed to the mutual accommodation of the two domains in response to external forces (Guo, 1996).

4.2 Polyphase successive orogenies

Polyphase successive orogenies occurred in the Tethys tectonic domain since the Late Permian and in the Northwest Pacific tectonic domain since the Late Triassic. The

interaction between the median Turkey–Central Iran–Gangdise plate and Indian plate on the one hand and the Eurasian plate on the other and between the Kula–Pacific plate and the Eurasian plate gave rise to the successive orogenies to create the Nanhua orogenic belt as a result of the eposodic release of compression–shear stresses (Fig. 1), whose general trend and direction remained relatively unchanged.

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